dulating, as the ribs are produced upward upon those above them, leaving little concavities between.

Pleurotoma (*Mangilia*) *Pellyi*.

Testa elongate ovato-fusiformis, alba, inter costas superne prope suturam et versus basim anfractus ultimi purpureo-fusco tincta; anfractus 8, primus parvus, convexus, sequentes 2 læves, medio carinati, cæteri leviter convexi, costis 7 continuis (in anfr. ultimo basi fere continuis) instructi, ubique spiraliter minute striati; apertura parva, ovata, longitudinis totius $\frac{5}{13}$ æquans; labrum costa ultima maxima extra valde incrassatum, vix sinuatum; columella callo crassiusculo labro juncto amicta; canalis brevissimus.

Long. $6\frac{1}{2}$ mill., diam. $2\frac{1}{3}$.

Hab. Persian Gulf (*Colonel Pelly*).

The seven strong ribs are continuous up the spire, thus making the shell heptagonal. The labrum has a purple-brown spot, which is the termination of the interrupted band around the base of the body-whorl, near the lower end of it.

Pleurotoma (*Mangilia*?) *acutangulus*.

Testa elongata, subfusiformis, alba, juxta suturam et ad caudam purpureo-rufo tincta, et circa medium anfr. ultimi zona angusta ejusdem coloris cincta; anfractus 8, supremi duo læves, tertius granose reticulatus, cæteri medio acute angulati, costis subacutis 7–8 supra spiram irregulariter continuis et versus basim anfr. ultimi evanidis instructi, circa angulum lira spirali tenui cincti, et ubique exiliter spiraliter striati; apertura albida, zona externa ornata, longit. totius $\frac{1}{3}$ paulo superans; labrum costa ultima incrassatum, vix sinuatum; canalis breviusculus, angustus.

Long. $7\frac{1}{2}$ mill., diam. $2\frac{1}{2}$.

Hab. ——?

This species is remarkable for the acute angulations of the whorls, the spiral liration at the angle, and the purplish-red bands at the suture and the middle of the last whorl, the latter being visible within the aperture. The number of ribs appears to vary from seven to eight; and they are not quite regularly continuous from the apex downwards.

[To be continued.]

XIX.—*Note on the Echinoderm-Fauna of the Island of Ceylon, together with some Observations on Heteractinism.* By Prof. F. Jeffrey Bell, M.A.

We know so little about the fauna of the seas around the island of Ceylon that, though there is no reason to suppose

they will be found to teem with many new forms, it seems to be of interest and importance to give a brief statement as to what may be found by an active worker who will devote a short time to the occupation of collecting.

Dr. Ondaatje, Colonial Surgeon in Ceylon, has lately arrived in England, and has presented the Trustees of the British Museum with, *inter alia*, a collection of Echinoderms, of which the following is a list.

ECHINOIDEA.

1. *Diadema setosum.*

Well as the spines of this species are known to vary, I do not know whether a specimen with a number of its spines perfectly white, while others are more or less dark brown, has ever been put on record.

2. *Echinometra lucunter.*

It is well to have evidence that this widely distributed and very variable form is found off Ceylon.

3. *Salmacis bicolor.*

Since the time when I communicated to the Zoological Society some observations on the Temnopleuridæ*, and when the only specimens in the British Museum from a definite locality were those collected by H.M.S. 'Challenger' at Zamboanga, examples have been received from Port Molle (E. Australia) and from Mauritius. This species, then, is another of those which may be expected to be found throughout the whole area of the Indian Ocean.

Some years ago Dr. von Martens described a species which he called *Salmacis conica*; but this, in the opinion of Mr. Alexander Agassiz, is only a form of *S. sulcata*. The proportion of height to diameter in von Martens's species was 76·3 per cent.; the example now in our hands presents a proportion of 84 per cent.; and we have therefore the interesting case of the same kind of variation in shape presenting itself in two closely allied species in which, as a more ordinary rule, the longitudinal is never more than 65 per cent. of the transverse axis.

4. *Echinoneus cyclostomus.*

5. *Echinodiscus biforis.*

I adopt, provisionally, the specific name used by Agassiz in

* P. Z. S. 1880, p. 422.

his 'Revision of the Echini,' as the labours of nomenclature would become intolerable were one to make a critical review of synonymy on every occasion. I may point out, however, that by the arrangement of names in the 'Revision' Leske's clumsy term *bisperforatus*, which has some claims to priority, is not used for either of the species which he appears to have included under it.

ASTEROIDEA.

6. *Fromia milleporella.*

7. *Scytaster variolatus.*

Three small specimens are referred to this species; but intermediate forms, which should completely demonstrate the justice of their association with the mature examples, are still wanting to the national collection.

8. *Scytaster novæ-caledoniæ.*

This must be a most abundant species on the shores of Ceylon, and helps very much to point the moral of the danger of forming specific terms from localities with conspicuous names.

Several of the specimens present marks of injury; but only one has more than five rays, and Dr. Ondaatje tells me that, although he went to considerable trouble, he was unable to find a second example.

It is impossible to examine such a series as that now before me without being struck by the consideration that one factor in the production of abnormal forms among brachiate Echinoderms is the modification, or alteration, of the direction of vital activity due to the changes in an organism which must accompany so severe an injury as the loss of a large portion of one arm. It is not difficult to see that the result of such an injury might, of itself and by itself, be the production of two rays where one had previously existed, owing to increased activity, due to inflammatory action. A further result might well be a tendency, in a race of individuals of a certain species, to produce an irregular number of rays; occasionally, as in the case of *Asterias polaris*, this would be advantageous and would become a constant arrangement; as a rule, no advantage would be associated with it, and the phenomenon would partake only of the character of a sport.

This kind of variation may be called accidental, and may be presented by any species; some, however, constantly exhibit phenomena due to quite another cause (see under 15).

9. *Astropecten*, sp.

A small, not very well-preserved specimen, which seems to be more closely allied to *A. granulatus*, M. & Tr., than any form I have had the opportunity of examining.

Ophiuroidea.

10. *Ophiocoma erinaceus.*

11. *Ophiocoma scolopendrina.*

These two species appear to be both present in the collection; and it is interesting to note that what is ordinarily regarded as the general appearance of the one is to be found associated with the structural characters of the other—specimens with darker and lighter ring-marks on the spines presenting the swollen upper spines, while others in which the swelling of the upper spines is but faintly marked have the interbrachial spines on the lower surface of the disk almost, though not quite, bare of granules.

12. *Ophiocoma brevipes.*

13. *Ophiocoma pica.*

14. *Ophiothrix nereidina* (?).

Till the species of this genus have undergone some revision or been rearranged in smaller subgroups, there will often be considerable doubt as to the specific identity of a form not represented by several specimens.

15. *Ophiomastix annulosa.*

Although this species has been represented in the British Museum by specimens of considerable size, there has never yet been obtained one so large as that which we owe to the liberality and care of Dr. Ondaatje.

One specimen, which is nearly perfect, has its longest arm 300 millim. in length, while the disk is 28·5 millim. in *diameter*; another specimen, a good deal injured, has its disk 35 millim. in diameter. Here we can only guess at what the arms were or might have been: in the former specimen the arm, at a distance of 150 millim. from the disk, was 3 millim. wide, while it was 4·5 millim. wide at its base; in the latter specimen the arm, 5 millim. wide at the base, was 4 millim. wide at a distance out of 150 millim. It is quite possible

that this example may have had arms 400 millim. long, and a total spread of 800 millim., or something like 32 inches.

The naturalist of an earlier school would have been content to admire the delicacy combined with solidity of such an Ophiurid's arm; today, when the current of speculation has set in a different direction, we are rather inclined to ask, what is the character of the struggle for existence of so large a creature, offering five distinct avenues for attack? The very condition of the injured specimen whose admeasurements have just been given answers the question; there must be a constant tendency to the loss of an arm or a part of one. Where vegetative repetition is so abundantly displayed, that loss can of itself hardly affect seriously the individual, certainly not the species; but, in some cases, the danger may react on the species in this way: rather than part with an arm there may be a choice, due to an inherited tendency, in favour of a loss of individuality. The disk divides under the influence of attacks from without.

The consideration of external influences is not, I think, to be neglected so completely as it has been by some writers. Simroth, for example, addressing himself to the "Cardinalfrage," "ob die Theilung der Seesterne überhaupt eine freiwillige sei, oder nur durch gewaltsame äussere Eingriffe bewirkt werde," decides in favour of the former*; and Prof. Häckel, who even uses the epithet "spontane," writes, "Bei gewissen Seesternen lösen sich die Arme freiwillig von der Scheibe ab" †. Of course, nothing more is meant by "voluntary" in this connexion than that the writer is unacquainted with the history of this tendency to fission, or with the character of the external stimulus that brings it into play.

The well-known observations of Kowalevsky and others afford sufficient evidence of the phenomenon of what may, in a sense, be spoken of as voluntary fission; but it is obvious that in so saying we are not at the bottom of the matter, and that it is unphilosophical to seek for no explanation beyond that of the dictates of a free will.

A capacity for self-injury appears to have been a dominant character in the primæval Echinoderm; the Holothurian of today can be easily roused to such a state of physiological excitement that he will eject his viscera; so, it seems, under another form did the Astrophiurid stock retain this tendency.

Under the influence of pain, fear, or anger, a starfish throws off an arm, or an Ophiurid divides its disk, fission of the disk

* Zeitschr. f. wiss. Zool. xxviii. p. 421.
† *Op. cit.* xxx. (Suppl.-Bd.) p. 435.

being the only possibility when centralization has extended so far. In the next place, it is to be noted that when the divided disk heals and buds afresh it may give signs of the loss of the quinary principle, and more than two arms may take the place of the two that are gone. The tendency to fission, the child of external irritation, became the parent of a habit of fission or simple reproduction. Carried on under certain conditions this habit led to yet another change; the permanently or characteristically sexradiate form, both in the north and in the south (*Ophiacantha anomala* and *O. vivipara*) ceased to have free-swimming embryos, and became viviparous. Here is cenogeny indeed! not only no trace of the bilateral symmetry of the embryo, but loss of quinary proportion in the adult!

Results so remarkable as these must not be dismissed as "freiwillig;" it seems that the tendency of an Echinoderm to break up under external irritation must be taken to be a proved fact. Passing from it forwards we recognize as an expression of this tendency, now crystallized into a habit, the fission of the Ophiurid disk; in some of the Asteroidea the tendency has become economized or concentrated, and only a single arm separates from the disk.

If, however, instead of passing forwards and coming within the range of heteractinic phenomena, we pass backwards into an earlier condition, and try to work out the cause of this tendency to division, we find ourselves brought face to face with polyactinism, a stage which must certainly be regarded as earlier than a fixed pentactinic condition. Here we find (*Brisinga, Labidiaster*) that the separate arms appear to break off for the purpose of setting free the genital products—a condition not inexactly paralleled by that zoological paradox *Palolo viridis*, and bearing a significant analogy to what obtains in some Discophora, where the researches of Prof. Häckel and of Dr. Romanes (whose work would not seem to have been consulted by Prof. Häckel) have shown that in some cases, at any rate (*Aurelia aurita*), the phenomenon of strobilation is associated with very great variability; or, to put the matter more generally, reproductive fission in low forms (or early stages?) is more or less indefinite in direction.

The origin, then, of the habit of self-mutilation in the Echinodermata is to be sought for in the imperative necessity of reproducing the species; as concentration and consolidation went on this habit disappeared, to be again roused into activity by the attacks of enemies. Thus roused, it has, in some groups, become definite in direction, and has again become a factor in reproduction. But the difference is a real one: at

first it was merely for the evacuation of the genital products; today it is true asexual reproduction; and, wide as is the physiological, just as wide if not wider is the historical gulf. Between the two there stand the phenomena of adaptation to environment; in some cases this has been so complete (development of spines, marginal plates, odours) that the starfish fears no foe; in others, as in *Ophiomastix*, vegetative repetition is capable of atoning for all or much that is lost; in others, lastly, neither strength of spine nor length of arm suffices; and then the dangers to the species are atoned for by a modern recurrence to the ancient habit of fission.

The account given by Prof. Häckel of the different methods of reproduction may perhaps be conveniently modified, and put to stand thus:—

A. Sexual reproduction.
  (α) With metamorphosis ("metagenesis and internal gemmation").
  (β) Without metamorphosis (viviparous Echinodermata).
B. Asexual reproduction.
  (α) Fission, with repair.
  (β) External gemmation from a single arm.

A tabular arrangement of the stages of reproduction and fission may be useful:—

I. General break-up of the organism. Compare *Palolo*.
II. Gradual or regularized loss of the arm. Compare the Discophora.
III. Normal and combined evacuation of genital products through special pores.
IV. Injury to arm by external enemy. Compare tail of lizard.
V. Loss of arm (or division of disk) on irritation.
VI. Arm (or disk) gives off buds.

16, 17. *Ophiactis Savignii.*

In addition to a sexradiate example of this very widely distributed species, there are three specimens, two of which are sexradiate, of a species, not now to be exactly determined, which would appear to belong to the genus *Ophiacantha*. Here the sexradiate condition may possibly be an accidental variety. The specimens are all small and perhaps immature; at any rate, they present no evidence of that viviparous condition which, as is well known, is seen in some, at any rate, of the sexradiate species of that genus.

18. *Astrophyton clavatum.*

Broken pieces indicate the presence at Ceylon of a species which has as yet been only recorded from Zanzibar, though the British Museum has also specimens from Mauritius.

Crinoidea.

19. *Antedon*, sp.

Indications, the first within my knowledge, of a Comatulid from Ceylon are presented by a specimen with thirty-nine arms, only a few cirri, with about thirteen joints, the penultimate spine obsolete; with syzygies on the axillary distichal, axillary palmar, and third brachial; the next syzygy is on the eleventh brachial. The absence of a terminal comb from the proximal cirri induces me to suppose that the species belongs to the genus *Antedon*; and it would appear to be still undescribed; the dried condition of the specimen and the possession of only a single example forbid my describing it fully, or giving it a fresh specific name. I have urged on Dr. Ondaatje the advisability of preserving Crinoids in spirits; and I have little doubt that when he next brings or sends us a collection from Ceylon there will be some very interesting representatives of this ancient order.

It will be seen that Dr. Ondaatje has succeeded in obtaining an example from every group of the Echinodermata, with the exception of the Holothuroidea; and of these he hopes to make a collection on another occasion.

It will next be seen that a collection from Point de Galle, ranging thus over four classes, presents us with nothing new, except probably a Crinoid; the conditions of existence of a Crinoid with a *fixed larva* are so different from those of such other Echinodermata as have free-swimming embryos that nothing common to the two can justly be said.

Confining ourselves, then, to the other three classes, we observe that, as indeed we might have expected, the forms represented in this collection have all an exceedingly wide range; if we limit ourselves to the consideration of the single fact that Mauritius, Zanzibar, or the Mosambique are known stations in the area of distribution of all or nearly all the species, we shall see the point which is most forcibly urged by this collection. In the examination of the problems of geographical distribution, the homely fact of the presence of a powerful current must not be overlooked; and the recognition of its existence may sometimes save those who make a scientific use of their imagination from the necessity for feats of intellectual activity which, however remarkable when exhibited within the narrow arena of the students of a single group, are not always found to be acceptable to a wider audience.